Teacher-Created Materials Focused on Math-Problem Solving

Carla J. Rodríguez Ruiz

Thesis Director: Astrid Núñez Pardo M.A.

Universidad Externado de Colombia

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Note of acceptance

Astrid Núñez Pardo M.A. Thesis Director

María Fernanda Téllez Téllez M.A. Juror

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Abstract

This qualitative action research study explores the impact of designing and implementing teacher-created materials based on problem solving, on the comprehension of mathematical operations like addition and substraction among 17 transition level students in a private school located in Bogotá. The data- gathering instruments were children's artefacts, teacher's field notes, and focus group interviews. The results suggest that MD provided opportunities for students to associate their interests with mathematical contexts. Furthermore, MD helped students to improve their skills of math; operations. They had a proper uptake and feeling with images and worksheet presentation. Indeed, the teacher-created worksheets structures facilitated opportunities for problem solving in parallel during the implementation. The preeschoolers willingness to develop the problems involves the addition and the subtractions in a different context and using tangible materials, despite children's emotional struggle with problem solving procedures, they wanted to play and use realia. Furthermore, they started to skip the problem-solving procedures, and assumed a good solution procedure in the beginning of the implementation. Nevertheless, children solved, checked and exposed their ideas and solution to their classmates. Finally, students reached new forms to solve mathematical problems, especially addition and subtraction. Then, they practiced that in context and used the realia to solve the problems easily.

Keywords: materials development, problem solving, and math operations

Resumen

Esta investigación acción cualitativa consiste en analizar el impacto del diseño e implementación de guías de trabajo enfocadas en problemas matemáticos para la comprension de las operaciones matemáticas básicas, tales como, la adición y la subtracción. Este estudio se realizó en un colegio privado ubicado en Bogotá, con 17 alumnos de grado transición. Los instrumentos para analizar los datos recolectados fueron las guías de trabajo de los estudiantes, las notas de campo de la profesora y entrevistas grupales. Los resultados sugieren que MD brinda oportunidades para que los estudiantes asocien sus intereses con contextos matemáticos. Además, MD ayudó a los estudiantes a mejorar sus habilidades en operaciones matemáticas y tienen una aceptación y un sentimiento adecuados con las imágenes y la presentación de la hoja de trabajo. De hecho, las estructuras de las hojas de trabajo facilitaron oportunidades para la resolución de problemas en paralelo durante la implementación. Los niños en edad preescolar quieren desarrollar los problemas implican las sumas y las restas en un contexto diferente y utilizando materiales tangibles. A pesar de la lucha emocional de los niños con los procedimientos de resolución de problemas, querían jugar y usar realia. Además, comenzaron a omitir los procedimientos de resolución de problemas y asumieron un buen procedimiento de solución al comienzo de la implementación. Asi mismo los estudiantes resolvieron, verificaron y expusieron sus ideas y soluciones a sus compañeros de clase. Finalmente, los estudiantes alcanzaron nuevas formas para resolver problemas matemáticos, especialmente sumas y restas. Luego, practicaron eso en contexto. Ahora los estudiantes usan realia para resolver los problemas fácilmente.

***Palabras clave**:* desarrollo de materiales, solución de problemas, operaciones matemáticas.

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Description

This action research study aimed at analyzing the impact of designing and implementing teacher-created materials, based on problem solving, on the comprehension of mathematical operations of addition and substraction among 17 transition level students in a private school located in Bogotá.

Three theoretical constructs underpinned this study to answer the research question, namely materials development, problem solving, and math operations. Referring to materials development, I found relevant information in the theoretical contributions of several scholars, such as Canagarajah (2005), Kumaravadivelu (2016), Littlejhon (2012), Masuhara (2011), Montijano (2104), Núñez and Téllez (2004, 2009, 2015), Núñez, Téllez, and Castellanos (2012, 2013, 2017a, 2017b), Rico (2005), and Tomlinson (2011, 2012). Regarding problem solving, Polya (1945) Huertas (2017) Ayaz, Mehmet, Aydoğdu and Mustafa (2008) Heine (2010) Wise (2016) Rivera (1996) Thomson's (2009), supported my study with their significant contributions to this matter. Finally, I considered Rivera (1989), Fuson and Fuson (1992), (Fritz et al., 2014, p. 144). Baroody (2016) along with their theories, to elaborate the construct of math operation.

The findings of this study suggested that the group work and discussions may create a friendly atmosphere as students feel motivated when working with their peers as they can learn from one another and share their ideas and resources to join efforts to solve math problems. Besides, teachers should be understanding and warm-hearted to create an enjoyable and interactive setting, as the one previously described.

Furthermore, children's emotions were lost when they had the need to play realia. Likewise, these topics related to students' lives simplified the exchange of ideas fostering the development of critical thinking skills. Students' context increased the possibilities to express reflective, organized, and consistent standpoints. Moreover, the worksheets, the model bar

including blocks, teddy bears, jelly beans, and marshmallows helped students solve math operations. Also, the students started to inspire and motivate; however, after working on four worksheets centered on the same structures, it affected their interaction with the material and motivation. Lastly, students reached new forms to solve mathematical problems, especially addition and subtraction. They practiced them in context and also used realia to solve the problems easily.

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Content

This research study comprises five chapters. The first chapter encompasses the research problem. The second chapter covers the literature review. The third chapter describes the methodological design. Chapter four addresses the findings and results. Finally, chapter five underscores the conclusions, pedagogical implications, limitations, and questions for further research.

Methodology

The qualitative approach framed this study considering that it is a systematic activity to comprehend the educational phenomenon (Sandin, 2003). Besides, this study is an action research as it involves specific actions to identify and solve a problem. (Parsons & Brown, 2002). The participants were selected with the convenience sampling technique (Gravetter & Forzano, 2005). The data was analyzed using the grounded theory (Patton, 2002), the color-coding technique (Bianco, Gasparini & Schettini, 2014), and two types of triangulation, the theoretical and the methodological (Denzin & Lincoln, 1994). The pedagogical intervention consisted of the design and implementation of six worksheets that covered four classes to develop. Accordingly, six Second Language Acquisition principles (Tomlinson, 1998) informed this pedagogical intervention with the corresponding instructional objectives. Particularly, this pedagogical intervention constitutes an innovation for the Jordan de Sajonia School as it was the first contextualized research implemented in this setting (Núñez et al., 2012, 2017). Thus, it implied a change in my teaching practices and the teaching context.

The theory of the nature of language was the functional perspective and the theory of language learning was the cultural and ideology perspective (Tudor, 2001). Teaching for x problem solving and math operations, Understanding Polya (1945) was the method that underlined this pedagogical intervention which was contextualized with the philosophy of the school focuses on the socio- critical bilingual model. (JDS philosophy). Finally, the instructional phases were applied as follows: proposal of a customized framework addressing the particularities of JDS, students' sensitization, materials' creation and piloting, informed consent letters, and materials' implementation.

Conclusions

In reference to the first research category, MD provided opportunities for students to associate their interests with mathematical contexts. Furthermore, MD helped students to improve their skills of math operations. They had a proper uptake and feeling with images and worksheet presentation. Indeed, worksheets structures facilitated opportunities for problem solving in parallel during the implementation. Even though, after four session students declared being tired of working just in the books and making math operations without any help. This situation made me think of other possibilities to adapt and create materials in response to students' needs and interests.

Similarly, in problem-solving activities the preeschoolers want to develop the problems involving addition and subtraction in a different context and using tangible materials, as mentioned by Reys (2006) "Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves" (p. 6). Despite children's emotional struggle with problem solving procedures, they wanted to play and use realia. Furthermore, they started to skip the problem-solving procedures, and assumed a good solution procedure in the beginning of the implementation. Then, they omitted understanding and planning steps, and the most important stages to contextualize the problem. Nevertheless, children solved, checked and exposed their ideas and solution to their classmates.

In regards to math operations, students reached new forms to solve mathematical problems, especially addition and subtraction. Then, they practiced that in context. The students use the realia to solve the problems easily as declared by Baroody (2016). Moreover, they showed difficulty to use the model bar to solve problems and use the incorrect symbols of the addition and subtraction.

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Introduction

People are interested in learning a foreign language as this opens possibilities to make progress in different fields. For that reason, parents seek a bilingual school where their children are exposed to a foreign language in different subject matters. Colombia has implemented the learning process of foreign languages in the curriculum, in compliance to the General Law of Education 115 (1994), and the implementation of the National Plan of Bilingualism (2004-2019) by the Ministry of National Education (MEN, 2004). To comply those regulations Jordan School teaches mathematics, science, phonetics, reading, technology, social science, arts and music in English, since 2013.

As a math teacher, I am aware of the complexity of teaching mathematics to young children who have not learned the terms in Spanish yet, which makes difficult for them to understand the basic math operations without tangible help with which they can interact and solve problems dealing with addition and subtraction. That is why, I want to help pre-schoolers to understand math operations in an enjoyable way by using English in the design of teacher-created materials (Vargas, 2018, p. 4), based on problem solving.

This document comprises five chapters. The first chapter portrays the statement of the problem, the related studies, the setting and rationale, the research questions, and general and specific objectives. The second chapter presents the literature review and describes the purpose of the study and the theoretical constructs. The third one delineates the methodological and instructional designs. The fourth chapter presents the data analysis and exhibits the findings. Finally, the last chapter portrays the conclusions, pedagogical implications, limitations, and possible inquiries for futher research.

Chapter I

Research Problem

Statement of the Problem

Jordan de Sajonia is a private school that offers a bilingual education program in both elementary and high education. The most complex aspect of this program is starting to learn mathematics in English in pre-school, when children do not even know the terms in their mother tongue, and they have to solve mathematical problems involving addition and subtraction.

Since those operations are complex even in Spanish, they get easily confused, and sometimes frustrated for not understanding or being unable to perform the operations due to the lack of vocabulary and the fact of being easily distracted. On the other hand, mathematics operations such as addition and subtraction are new concepts for them and the printed materials used in the shool are not specially designed to teach mathematics in English. Therefore, I propose the creation of materials to aid students' comprehension of these mathematical operations. In spite of having plenty of teaching resoruces, they are not contextualized since they do not respond to the children's particular needs.

In my observation of pre-school mathtematics class, I identified the abovementioned problem through three data-gathering instruments. First, I kept my class observation notes in a reflective journal focused on the potential problematic areas of my preschoolers in regard to solving mathematical problems such as addition and substraction. Second, I designed and administered a survey (See Appendix A) to ratify the problem previously identified in the first instrument. Based on some institutional archival documents like the School Bilingual Programme and its curricular matrix (PEI, 2017) I confirmed the need to teach the children the abovementioned mathematical operations, and pondered the inquiry below.

Research Question

What is the impact of designing and implementing teacher-created materials, based on problem solving, on the comprehension of mathematical operations like addition and substraction among pre-schoolers in a private school?

Research Objectives

General objective: To describe the impact of designing and implementing teacher-created materials, based on problem solving, on the comprehension of mathematical operations like addition and substraction among pre-schoolers in a private school.

Specific objectives: (a) To assess the suitability and effectiveness of teacher-created materials, based on problem solving, for the comprehension of mathematical operations like addition and substraction; (b) to analyze the usefulness of the problem solving in the comprehension of basic mathematical operations; and (c) to describe the way in which students solve mathematical operations such as addition and substraction.

Related Studies

The related studies described in this action research are suitable to identify how the authors examined the constructs of this research: materials development, problem solving and math operations in a bilingual teaching context.

In regard to materials development and problem solving, Huertas' (2017) action research study explored the effect of developing and implementing worksheets centered on mathematical problems to promote three oral communication micro skills: conveying links and connections between events, accomplishing communicative functions of the language, and using non-verbal language to convey meaning. The researcher conducted her study with 25 children from first grade, aged 6 to 7 years old, in a private school in Bogotá, Colombia, and collected data by

means of students' artifacts, teacher's field notes, and video recordings. The results evidenced that the children had plenty of opportunities to enhance their oral communication micro skills; contextualized worksheets helped the children to establish contextual relationships to make sense and accomplish communicative functions of the language like classifying, describing and comparing. The children recognized the usefulness of communicating ideas through body language, and learned mathematic and geometry content through the Content Language Integrated Learning (CLIL). This study is relevant since it provides both theoretical support for the constructs that underpin my study and model the design of contextualized materials (worksheets) based on problem solving.

Likewise, the action research study carried out by Diaz (2014) analyzed the importance of giving cognitive and metacognitive feedback to solve mathematical operations through virtual materials for third-grade students in Miguel de Cervantes Saavedra, a private School in Bogotá. Diaz created digital materials to help teachers and third grade children who found solving math operations difficult, in the process of learning math operations. The researcher collected the information through class observation and interviews. The findings demonstrated that the students' learning motivation increased; that giving feedback helped students to understand that they should be opened to make changes to the procedures followed in solving problems; they also learned math in an enjoyable way; and the teachers acknowledged the importance of using digital didactic materials, centered on students' needs, due to its ease of use and application. The importance of this study relies on the fact that it models the way to teach students to solve math problems via materials focused on the students' real needs.

In relation to problem solving and mathematical operations, the action research study conducted by Olaechea (2016) aimed at enhancing counting skills through solving mathematical problems by using the Content Language Integrated Learning (CLIL) as a vehicle for the design

of problem solving exercises. The exercises were designed on a math virtual application called "Have fun learning" based on adding up and subtracting in one number, designed for first grade children in a private bilingual school. The researcher found that the use of the application motivates the students to learn math in English in an enjoyable way.

Moreover, López (2010) accomplished a case study focused on the development of an educational sofware containing materials of math to aid teachers to maximize mathematical problem solving with 20 primary students in a private or public school. Data-gahering instruments were focus group interviews and the software. The results demonstrated that children increased their attention and class participation while working on the activities proposed in the software, and they learned to solve math operations and comprehended how to solve problems. This study is important to mine, regarding the creation of materials to increase students' attention and class participation.

Referring to mathematical operations and materials development, Moreno and Ruiz (2016) carried out a case study, where virtual manipulative objects created by the teacher, complements the mathematical process for students of primary of three different public schools in Bogotá. The main objective of these materials (virtual manipulative objects created by the teacher) was to combine problem solving, mathematical visualization and mental images, to facilitate the learning process of problem solving and help the students to do a better analysis by using virtual manipulative objects in the solution of math problems. The findings indicated that students enjoy the use of virtual materials aids at solving math operations; this makes that students solve the operations effectively without getting tired. Although this study was conducted in three public schools, it is important to my study because it shows how the use of teacher created materials ease doing math operations and motivate students to learn joyfully.

Similarly, Taharon (2007) carried out an action research study to analyze the conception of Polya on problem solving, stressing the importance of understanding problematic situations with eleven fifth graders in a private school located in Bogotá. The researcher used teacher's field notes, a didactic unit and an interview to collect data. The study demonstrated that the students understood the statement of the problem in the different basic math operation. This study was relevant for my research because it exemplifies the implementation of pedagogical models to develop the students' problem-solving skills.

Setting

This study took place in Jordan de Sajonia School, located in Chapinero, Bogotá. The participants were 17 pre-schoolers, 10 girls and 7 boys who attend eight class sessions of mathematics per week. The pedagogical project of the school focuses on the bilingual model. Most teachers focus their methodology and class process on the procedure proposed in the textbook assigned. The school offers a bilingual education program implemented since 2014, integrates bilingual subject matters for the internationalization of the school community. The Bilingual Program of the school promotes the learning of English as a Foreign Language (EFL).

Rationale

The present study is the result of my reflection on my teaching practice in the school. I observed my pre-schoolers' learning process and noticed their weaknesses in doing basic operations: adittion and substraction. Thus, they required special attention because mathematics is a compulsory subject that is taught in English. As they have very basic proficiency in the mother tongue (L1) they still make different mistakes, probably as a result of interference with the native language effect, which is transferred to the solution of math problems.

This study contributes to my personal and professional development because it helps me as a teacher, and my students to improve their performance in math operations, and enhance their

problem-solving proficiency progress from the first pre-school grades. This study also aims other teachers to develop their own materials and implement worksheets based on mathematical problem-solving activities to reinforce math operations mentioned above.

Likewise, the development and implementation of worksheets and the use of realia constitute a contribution to improve my students' learning process, and foster the creativity of the EFL teachers who wish to innovate in their teaching context via teacher-created materials and the use of realia to facilitate mathematical operations in preeschoolers.

Finally, this study priviledges the research line on Materials Development and Didactics, ascribed to the research group Critical Pedagogics and Didactics for Social Transformation (Núñez, Téllez & Castellanos, 2013) since it addresses the three guiding principles of this line. First, the principle of "justice, equity and inclusion" (p. 6) as its purpose is precisely ensuring that we, as teachers, educate our students based on the values of justice, equality and inclusion. Second, about the principle of "empowerment and autonomy" (p. 7) Rico (2002) mentions that empowerment is the ability to influence others, that is why we must create awareness to seek a change in our society and therefore, we have to transform the thinking of our students. Third, the principle of "quality assurance and professional development" (p. 8) as Montoya (2012) suggests, teachers should keep up professional quality through extended education programs, in search for pedagogical updates, and the transformation of education and society. The next chapter portrays the literature review and the theoretical constructs underlying the study.

Chapter II

Literature Review

The main purpose of this study is to describe the impact of designing and implementing "teacher-created materials" (Ur, 1996, p. 201), based on problem solving, on the comprehension of mathematical operations among pre-schoolers in a private school. This chapter describes the three theoretical constructs that support the development of this research study: Materials development, problem solving and mathematical operations. In this section, I first show some important theoretical considerations about Materials Development (MD henceforth) regarding its possible contribution to both problem-solving and mathematic operations. Second, I refer to mathematical problem solving through realia in search of an effective way to solve problems. Third, I elaborate on the math operations, in view of the aim of this study, to help children solve basic operations: addition and subtraction, and use English when doing it.

Materials Development

MD facilitates learning in different environments according to the students' needs. Tomlinson (2003) states that "Materials Development is both a field of study and a practical understanding" (p. 13). In that sense, the development of materials is applicable to a specific field and it helps teachers to have a better understanding of what the development means. In the same line of thought, Núñez, Téllez and Castellanos (2013) assert that "MD is a field of study focused on the effect of materials on the teaching-learning process of a foreign language" (p. 57). Along similar lines, Núñez (2010) sustains that "the ultimate goal of developing materials is to guide students' language learning process" (p. 45). Núñez at al. (2013) further affirm that "the practical endevour of developing materials seeks to have the participants make more inclusive didactic proposals to respond to the country's agenda that is expected to be built in the educational settings" (p. 7). Since teachers are active agents of cultural and social transformation, they are

committed to engage students in the activities that allow them to build new knowledge to meet their needs and interests.

Defining materials. Prior to describe the type of materials, it is pertinent to define the concept. Núñez et al., (2004) depict that materials are units, lessons, workshops, worksheets to promote effective learning in teaching settings and encourage students' language learning process, the materials can be printed, online, DVDs or CDs. In reference to materials, Tomlinson (2012) asserts that materials are "anything which can be used to facilitate the learning of a language including course books, videos, graded readers, flash cards, games, websites, and mobile phone interactions" (p. 143). Besides printed and virtual materials, there are all sorts of resources to enrich methodological and didactic procedures and increase students' motivation.

Concerning the concept of materials, there are different definitions and views. González (2006) points that "Materials are an essential component in teaching" (p. 102). Likewise, Núñez et al., (2013) hightlight that "materials should keep a balance among students' language learning and affective needs, interests, expectations, and the institutional policies. They must also foster pair and group work to enhance motivation and self-esteem in students" (p. 5). To this respect, Núñez and Téllez (2009) stress that developing materials also have significant advantages and increases the students' participation and motivation. MD facilitates language teaching and learning since materials are useful instruments that support the class process. Based on Tomlinson's (1998) considerations, materials are effective if they facilitate the learning process and increase the learners' knowledge and understanding. Finally, Rico (2012) considers that the power of materials constitutes a function as sociocultural mediator because materials create a connection between the communities and the cultural encounters. In this vein, materials make learning easier and have an important role in our pedagogical practice because students realize

that their needs and interests are the foundation of the design, creation, and adjustment of materials. Therefore, they feel involved in the process and learn collaboratively. Besides, they create sociocultural association between materials and their daily lives, as well as meaningful learning.

Differentiating authentic from non-authentic materials. In general terms, materials may be classified into those created for general communication and those developed for educational purpose. In other words, the former ones are authentic and the latter, are non-authentic materials. Regarding authentic materials, Gilmore (2007) contends that they "offer a much richer source of input for learners and have the potential to be exploited in different ways and on different levels to develop learners' communicative competence" (p. 103). On the other hand, non-authentic materials are designed with academic purposes. Authentic materials develop students' ease of exploration and are created primarily to bring them closer to real situations and are not designed for academic purposes. On the subject of non-authentic materials, Gilmore (2007) asserts that "non -authentic materials, particularly audio-visual ones offer a much richer source of input for learners and have the potential to be exploited in different ways and on different levels to develop learners' communicative competence" (p. 103). Likewise, Montijano (2014) attests that "undeniably the best materials that students may enjoy: personalized, as they cater for different learning styles, and relevant because they respond to the learners' needs as no other material can do" (p. 281). That's why nowadays, kids are in a sociocultural context that evolves day by day. For this reason, teachers have the responsibility to create a classroom atmosphere to identify and meet the students needs, the use of non-authentic materials like worksheets, workshops, educational videos and games, and strengthen the process of learning that allows the children's accomplishment of their goals.

Types of materials. When teachers use materials to teach a subject matter in a foreign language, they need diverse materials to implement in class. On this matter, Richards (2001) suggests that "these may take the form of *(a)* printed materials such as books, workbooks, work-sheets, or readers; *(b)* nonprint[ed] materials such as cassette or audio materials, videos, or computer-based materials" (p. 251). Likewise, Tomlinson (as cited in Tomlinson, 2013, p. 2) states that it "can be linguistic, visual, auditory or kinaesthetic, and they can be presented in print, through live performance or display, or on cassette, CD-ROM, DVD or the internet. Accordingly, materials are wide and diverse and can be used in any academic field because they are a source of creation of significant learning.

Designing materials is a process that involves engagement and the ability to develop new ideas by teachers as materials developers. In this sense, Núñez and Téllez (2015) argue that "the outcome of this process comprises materials like a book, a module, a didactic unit, a workshop, a worksheet, a lesson, or a learning task" (p. 57). Tomlinson (2012) affirms that teachers should select and adapt the materials to students' needs, and if necessary, change it. To this regard, adapting and creating materials to meet students' needs make them easy to understand, fun, and useful for students. Designing materials is a process to foster new ideas to teach students. Considering that, Núñez and Téllez (2015) affirm that "the outcome of this process comprises materials like a book, a module, a workshop, a worksheet, a lesson, or a learning task" (p. 57). This statement supports the purpose of this study to develop and implement six worksheets focused on problem solving to boost pre-schoolers' comprehension of mathematical operations, and entail realia in activities to solve math operations. The worksheets are a useful instrument to facilitate and ease children's understanding. On this matter, Tomlinson (2012) asserts:

As teachers have increased access to computers, they are more easily able to create materials for classroom use. With the addition of graphics, worksheets look better and are more easily understood. When materials can be easily modified, a teacher is more likely to incorporate learners' feedback" (p. 322).

Since teachers have the possibility to assess and pilot materials, they can also make adjustments to make them more efficient and suitable based on their lerners' comments and suggestions.

Having explained the construct of MD, the following section describes mathematical problem solving, the second construct underpinning this study.

Problem Solving

Problem solving is the modern methodology for the teaching of mathematics. It creates students' critical thinking of their context and it is also easier for them to relate it to the mathematical problems developed. The teacher is in charge of allowing students' analysis of mathematical problems and guiding them in fiding the solution to mathermatical oprations, and motivating children to solve them properly. On the other hand, Huertas (2017) underscores that it is important "as the teacher leads the students to develop creative thinking focused on strategies, and enables them to develop critical thinking skills such as interpretation, analysis, evaluation, inference, explanation and self -regulation" (p. 24). To this point, Polya (1945) declares problem solving as the way to analyze problems and find the proper solution; it also creates strategies to develop students' critical thinking by a deep analysis of the problem itself.

As stated by Polya, strategies help students improve their level of critical analysis, while improving other aspects such as observation and the recognition of relevant information.

The importance of problem solving. Problem solving is key to create critical thinking in students and helps them to explore and promotes the practice of problem solving as it happens in

their daily lives they become generators of solutions rather than creators of problems. Polya (1945) states that "Problem solving activities develop several abilities in the students to promote advanced ways of thinking and make progress to develop learning process, through description and comparison base-activities". Problem solving facilitates students' significant learning process based on activities aimed at comparing and describing to develop the problem. Thence, problem solving fosters students' better adaptation to the development of basic mathematical operations.

Regarding methods, answers and solutions, Ayaz, Mehmet, Aydoğdu and Mustafa (2008) suggest that problem solving is useful to state the difference of the words "method", "answer" and "solution", which together are important since every problem has a method, a response and a solution. The authors mention The Three Domains of math problem solving regarding the importance of having a clear idea about these three contexts in the moment of practicing the resolution of problems. It is worth mentioning that every problem must be solved, and an answer obtained. The authors further mention that the resolution of problems is essential in the life of the students since the person facing them, wants or needs to find a solution. As there is not a procedure available to find a solution, children must make an attempt to find it.

Parameters for the implementation of problem solving. To solve math problem, it is necessary to understand and analyze it, discuss about possible solutions, and find the solution. To solve mathematical problems, we can use 4 stages proposed by Polya's (1945) theory, which indicate that the problem must be understood and interpreted; it is important to adapt the content of the problem to understand it, depending on the level of understanding of the person, and keeping in mind the essence to avoid misunderstanding. The author also mentions the creation and implementation of a plan to define the strategies of understanding and finding a solution. The third stage entails the plan developed and processed to give a solution once the group finishes the

discussion and identifies the possible solution. The fourth stage comprises the answer to the problem where the solution is fully developed.

The importance of problem solving in Math operations. Mathematical operations such as addition and subtraction can be solved in different ways. An effective method to solve these mathematical operations is Polya's (1945) problem-solving method in which students have the need to learn these basic operations. It is sometimes difficult to associate these operations with a contex. However, Polya's (1945) theory of solving problems gives us a clear idea of how to contextualize these operations in different problems that fit the contexts where students are exposed to a daily basis. In the same vein, Heine (2010) mentions that "we need a theoretically well-based model of how language and problem solving are interrelated in cognitive processing in general. I will suggest such a model, which integrates the so-cio-cultural embedding of the cognitive processes" (p. 5). Thus, problem solving is a link of understanding and interaction among students and their mathematical operation process.

Moreover, mathematics operation is important in the solution on problem solving because it allows students to reflect on the process, share ideas and clarify concepts to state relations of mathematical perceptions. When students solve problems and use this concept to implement them in the solution of basic operations, they reflect and expand their ideas to analyze, understand, operate and argue their understanding. Besides, they have the opportunity to solve the basic math operation through solving problems. According to Wise (2016), "Many times children have trouble solving word problems because they do not know which operation (+, -, X, ÷).” Thus, it is crucial to follow the 4 stages of problem solving proposed by Polya, so that students better comprehend, make sense and analyze basic operations and, solve problems successfully.

On the other hand, Wise (2016) affirms that research indicates that identifying keywords, pulling out relevant information, and creating visuals to represent math problems are effective

methods for helping students comprehend word problems from the inside out. In this sense, students need pedagogical procedures to help them understand the problems and at the same time, develop mathematical operations.

The importance of MD in problem solving. Students require to develop or represent the problems by drawing, underlining main ideas, or even using real objects to make sense of the problem. In this regard, MD eases understanding and analyzing mathematical problems. As mentioned by Wise (2016):

> If you want to make things even more concrete for the child you can try using real objects such as fruits, coins, or math Manipulatives to represent the objects in the pictures. Some children do better when they can touch, move, and set up the objects that represent the problem. (p. 82)

Then, we realize that MD like the worksheets supported by realia play an important role when solving mathematical problems since it contextualizes the students with the problem that they are solving. To conclude, Rivera (1996) stated that:

> Young children's problem-solving abilities have been seriously underestimated. They suggest that there is an effort to make sense out of problem situations, they come to believe that learning and doing mathematics involves solving problems in a way that always makes sense. (p. 85)

Accordingly, MD is fundamental in problem solving as the teacher designs the worksheets to address specific needs of the group, and provides guidance to support and contributed to students' sense of achievement in their learning process. Despite the weight of learning, discussing and solving a mathematical problem, these stages would not be possible

without accomplishing the process of Math operations to create the problems. Then, the best way to teach math operation has special relevance in this research.

Mathematical operations. Math operations like addition and subtraction are the basic operations for the learning of mathematics that is why we as a teacher have to take special care when teaching this type of operations to preschool students because they can feel confused and frustrated when they cannot differentiate between one of the other (addition – subtraction) and also in the process of implementing the numbers in another way that is not just count 1 to 100. According to Rivera (1989), "The Curriculum and Evaluation Standards for School Mathematics (NCTM 1989) recognizes that addition and subtraction computations remain an important part of the school mathematics curriculum and recommends that an emphasis be shifted to understanding of concepts" (p. 45). The term mathematical operation refers to a conceptual or a procedural representation. Nickson (as cited in Rivera, 1996) expressed:

> It is important, he points out, in exploring the mathematics classroom from the perspective of the culture, it generates, to remember that we are concerned with the people in the setting and what they bring to it. Nickson adds that we must increase our sensitivity to the importance of their hidden knowledge, beliefs, and values for mathematics education. (p. 48)

Concerning the applicability of field, in Thomson's (2009) words it "Helps kindergartners gain confidence and demonstrate to them the real-life usefulness of math. This can create a lifelong interest in math that helps students excel when they reach more challenging math classes "(p. 35). Correspondingly, Math operations become part of people's life. In the family context, children practice problem solving and perform mathematic operations to manage their budget for snacks, or when interacting with friends and partners in games and other type of competitions.

MD in mathematical operations. The use of materials created by the teacher, and supported with realia, shows tangible results in the teaching of addition in English because when students manipulate objects and use them for the mathematical operation, it connects them more with the results they want to attain. Conversely, Engelhardt and Usnick (as cited in Rivera, 1996) demonstrated that "while no significant difference between second grade groups using or manipulative was found, significant differences in the subtraction algorithm favored those of addition with manipulatives" (p. 50). Moreover, Sutton and Urbatch (as cited in Rivera, 1996) recommended the use of base-ten blocks, beans and bean sticks or beans and bean cups to serve as manipulatives to use for trading games and with the "transition board". (A modified version of the base ten board). They also emphasized that attempting to teach addition and subtraction without initial preparation of the student with trading games could be counterproductive and result in lack of understanding due to lack of preparation" (p. 55). On this basis, teachers must plan each class activity according to students' needs, and provide a prior explanation so that the students understand each stage of the process. Besides, children need to touch and perceive and manipulate real objects directly to be aware of the appliance of learning strategies and the usefulness of knowledge in daily life experiences.

Addition and subtraction strategies. To teach basic operations, the use of strategies is vital to avoid frustration, as some children consider difficult to understand why they have to learn this type of operations and perform them. Fuson and Fuson (as cited in Rivera, 1996) found that in all of the groups studied, children were accurate and fast at counting up for subtraction as at counting on for addition. This contrasts with the usual finding that subtraction is much more difficult than adding over the whole range of development of addition and subtraction solution strategies" (p. 10).

Likewise, we notice students' struggle when subtracting; thus, teachers should desing and implement a pedagogical intervention entailing problem solving stages and contextualized materials supported by realia to help children understand basic operations.

Chapter III

Methodological Design

Research Design

This chapter defines the impact of the pedagogical intervention focused on the design and implementation of teacher-created materials, based on problem solving, on the comprehension of mathematical operations like addition and substraction among pre-schoolers. It defines the approach, the type of study, describes the participants, and the instruments used to collect data to support the intervention.

Approach. To develop problem solving in the solution of math operations, I assumed qualitative research approach to observe students' interaction in the development of math operations. In Lichtman's (2012) vision, this type of research should be descriptive, easy to understand and interpretate within a holistic approach, where participants can convey their interpretations in their own words to create a non-linear research. Burns (2003) affirms that "It offers descriptions, interpretations and clarifications of naturalistic social contexts" (p. 22). This study intended to interpret, understand, and describe a pedagogical intervention focused on the teaching of math operation through mathematical problem solving in preescolers. Therefore, the current study pursues an impact on the process of learning math operations in preschool students that participated in this research.

Type of study. Taking into consideration the integration of mathematics and problem solving, I selected action research as the suitable one for this study. In this regard, Wallace (1998) states that action research allows the analysis of information related to the professional practice and learning processes. Data collected to inform the research question arose from real educational contexts. During the implementation of the pedagogical intervention, I observed the class process

and analyzed data gathered through different instruments to guide and foster students' math operations skills with mathematical problem solving, and didactic materials to connect both with the mathematical content. Finally, I reflected on the results obtained.

Participants. The participants of the present study were preeschool students attending my math classes and myself, as teacher-researcher and materials developer.

Students. The population selected to implement this pedagogical intervention was one group of 17 preeschoolers, aged five to six years, in a private school in Bogotá. To select the participants, I considered the problems they faced when started to learn basic math operations.

Teacher-researcher and text developer. As a mathematics teacher I guided my students' process focused on developing math operations through mathematical problem solving, providing them with some strategies. Besides, my role was to attain the instructional objectives through the development of contextualized materials, since, as ststed by Núñez and Téllez (2009), "All teachers are potential materials developers" (pp. 183-4) as they "can engage in such process [MD]… by … creating their own materials" (Núñez, Téllez and Castellanos (2012, p. 28). Finally, as a researcher, I identified a research problem, built the theoretical foundations to inform it, desing and implemented a pedagogical intervention, collected and analyzed data, and reported the findings of the current study.

Data gathering instruments. The instruments I used for collecting, analyzing and triangulating data during this pedagogical intervention were students' artifacts, field-notes and a survey as I described below.

Students' artifacts. Artifacts guide researchers through the investigation and provide information about the students' process. I designed the artifacts that provided me with information concerning the development of math operations through problem solving. Lankshear and Knobel, (2006), define an artifact as an instrument, a physical support developed by

participants during the research process. In the current study, the development of worksheets and audio recording scripts were the artifacts that provided me with information concerning the enhancement of some oral communication skills through mathematical problem solving. I created six worksheets entailing math operations implementing the theory of problem solving and the use of realia to facilitate the learning of both math operations.

Teacher's field notes. Field notes provide detailed information about a particular lesson. Hopkins (2008) declares that "a field note is a way of reporting observations, reflections and reactions to classroom problems, which should be written as soon as possible after a lesson" (p. 116). In this study, the note taking process was descriptive and included data concerning with the setting of the lessons, and students' reactions towards specific moments during the classes. I took field notes before, in a previous similar group, while and after implementing the proposed intervention. I collected field notes at the end of every class session, and I used a chart including the students' progress in every class (See Appendix A). This instrument provided me with data about how students advanced during the process.

Focus group. Focus group is a useful tool determine in a specific group if the implemented theme is having an effect on the population on which the research is being done. Bader & Rossi (2002) mention that "is the label given to a special type of group interview that is structured to gather detailed opinions and knowledge about a particular topic from selected participants" (p. 2). To this research, it is important to use the focus group interview to know how students are learning the math operation through the solution of problems by using realia from their view.

Survey. Surveys are helpful to verify that the research is true and also to tabulate the needs of all those who take part in the research and determine the approach that the research

should take. In Burns (2002), through the surveys we can get information from the participants such as: who they are, what they have done in the past, what their interests and needs are, and what they think or feel about something. This instrument is useful to get specific information from each person.

Pedagogical Design

This section addresses the pedagogical intervention, its general and specific objectives, the innovation of the intervention, the theory of the nature of language and language learning, and the approaches that inform this pedagogical intervention and the connection of the research with the pedagogical intervention.

Pedagogical intervention. The pedagogical strategy that guides this study is the design and implementation of six worksheets focused on problem solving, to explore their impact on pre-schoolers' comprehension of mathematical operation like addition and substraction.

Second acquisition principles pertinent to MD. In the acquisition of language, teachers should consider several aspects taking into account that students have different qualities, behaviors, contexts and pace to learn. Núñez et al. (2009) state that "reflection awareness of and MD rationale, affect, motivation, teachers' beliefs, creativity, and commitment are the components that interplay in MD" (p. 57). In this vein, they assert that teachers' MD effectiveness allow students to succeed in EFL learning. Besides, MD fosters opportunities to reflect on professional performance. Furthermore, Núñez et al. (2009) encourage teachers to dicover their potential to create and innovate materials to have a better teaching and learning environment to achieve the academic goals proposed, and build on students' needs,.

Instructional objectives. The main objective of the pedagogical intervention is to design and implement six worksheets focused on problem solving and explore their impact on pre-schoolers' comprehension of mathematical operations like addition and substraction.

Specific objectives. The specific objectives to achieve in this pedagogical intervention are: (a) To create a supportive learning environment that fosters the students' comprehension of solving problems; (b) to promote the use of mathematical operation to solve problems; (c) to provide students with basic vocabulary related to math operations, and instructions to the solution of problems; (d) to facilitate the understanding of solving and checking problem situations.

SLA principles. Tomlinson (1998) states some basic principles of second language acquisition (SLA) to consider when designing didactic resources to encourage language teaching and learning or other fields of study. In this case, I considered six of them: (a) Materials should help learners to feel at ease to motivate and make students aware of their success, instead of feeling frustrated when performing extremely difficult tasks; (b) the worksheets should cause an impact on students with novelty and diversity of interesting activities; (c) materials should provide the learners with opportunities to use the target language to achieve communicative purposes, and discuss the solution for math problem activities. Tomlinson and Arnone (as cited in Núñez &Téllez, 2009) affirm that the left side of the brain processes time, sequence, speech and analyze, can recognize numbers and letters, while the right-side processes special awareness, recognizes faces, objects, places, and creative patterns; (d) they revealed that there is a need for a roughly – tuned input since it featured what the learners are already familiar with mat problem, but containing the potential for acquiring other elements of the inputs each learner might or might not be ready to learn; (e) regard students' emotions to let them feel relaxed and in a comfortable context to learn more and in a shorter time. (Dulay, Burt & Krashen, as cited in Núñez et al. 2009); (f) provide opportunities for outcomes feedback look for feedback to solve math other schoolar. As Dulay, Burt and Krashen (1983) assert, learner's individual motives, emotions and attitudes display what is presented in the EFLC, and result in differ. Moreover, Núñez et al.,

(2009), Núñez et al. (2009) and Nuñez et al. (2013) highlight Tomilson's (2003) SLA principles to develop materials and principles for MD.

Based on the SLA principles suggested above, and having in mind the school curriculum and the students' needs and features, I set up the objectives, and designed six worksheets focused on problem solving to help children comprehend the operations of addition and substraction to find the solution of problems.

Intervention as innovation. Innovating has become a very important part of the investigation. This defines that we can create new tools for students to learn in a more practical, more didactic and easier way than was previously learned. Núñez et al. (2004) affirm that "teachers as innovative professionals, have the potential to explore their creativity by designing materials for their classes" (p. 130). In this sense, as professionals of education we are committed to innovate and explore creativity to encourage students to increase knowledge as the foundation to build up their further education in the areas they choose. Also, Núñez et al., (2012) state that there are three reasons why developing materials fosters innovation. First, it involves several chances for decision. Second, teachers become active agents of transformation in language teaching. Third, in materials design, teachers are able to address their students' expectations and requirements. Moreover, Núñez, Téllez and Castellanos (2017a) sustained that "they [the in-service teachers] acknowledge the fact that it is possible to innovate in their EFL contexts through teacher-developed materials" (p. 24). In this study I have innovated with the development of teachercreated worksheets for solving addition and subtraction problems. Nicholls (as cited in Markee, 1992, p. 231) affirms that "an innovation is an idea, object or practice perceived as new by an individual or individuals, which is fundamental in nature and is planned and deliberate". This is what I intend to accomplish through the six worksheets proposed and the activities planned to the learning of math operations.

Theory of the nature of language and language learning. The theory of language that informs the language learning programme in Jordan de Sajonia School is the linguistic perspective, the fuctional perspective and the self-expression perspective, which according to Tudor (2001) and Hymes (1972), seeks that language takes an important place in a social context as a synonym of communication for the members of a community, This means, centering on students' interactions and their own social contexts is the main object of this intervention and also the language is a connection to develop ideas. Hymes (1972 as sited in Tudor, 2001) also assert that an experimental strategy emphasizes on the quantity of developing materials, as intended in the current study.

In the school context, I implement the linguistic perspective because students use the language to express themselves in English in the class context. Besides, they accomplish the functional perspective because students share ideas, work in pairs to read the problems, interpret them, and work in groups or in pairs to solve the problems. In the pedagogical intervention of this research study, the suitable language vision is the linguistic perspective because students have to use the language to express their ideas about the problems in English.

The language view meets the language learning programme followed in this study. The structural view, fuctional view and interactional view according to Richards and Rodgers, (2001) seeks language as a connection of interpersonal relations and social interaction among people. In this case, based on the students' needs to express their ideas, when interacting in English to ask questions about the way to solve problem on maths operations, and understand what they have to do. Teachers and students interact and share ideas through mathematic content.

Methodological approach underlying the pedagogical intervention. The approach that frames my pedagogical intervention is teory of problem solving of Polya and the Singapur

method to the teaching of math operations. In this method, I implemented the use of "realia" or manipulative materials as stated by Rivera (1996), "So the most important thing is that the use of manipulative materials gives the student enough strategies to develop a mathematical operation". Thus, it allows the use of realia through specific contents to solve math operation through problem solving.

Connection of the pedagogical intervention with the research question. To answer the research question: *What is the impact of designing and implementing teacher-created materials, based on problem solving, on the comprehension of mathematical operations like addition and substraction among pre- schoolers at a private school?* I envisioned an instructional design based on Richards' (2006) inquiry "Can extrapolate from research a set of principles that can be used to support particular pedagogical approaches" (p. 8). Then, I considered these instructional principles throughout the implementation of the worksheets desingned for my math class.

Instructional phases. The implementation entailed four specific stages as follows: proposed material development framework, informed consent, sensitization and implementation of the intervention.

Proposed material development framework. The pedagogical project of the school focuses on the socio- critical bilingual model. In the implementation of the present pedagogical intervention, I present a summary of different scholars' frameworks and theoretical foundations to design and implement materials. (Graves, 1996; Jolly & Bolitho, 1998; Masuhara, 1998; Masuhara, 2004; Núñez et al., 2004; Núñez et al., (2009); Núñez, Téllez, Castellanos & Ramos, 2009; and Núñez, et al., 2012). Graves (1996) include resources and constraints. Masuhara (1998) considers the design of a syllabus, and Jolly and Bolitho (1998) adds the identification of a problem and the contextual realization of the proposed new materials, (exploration of the

problem, defining what skills, what functions). Núñez et al. (2004) embrace the learning and teaching activities, the materials required students to perform, type of participation, and the students' use of background knowledge; Núñez et al., (2009) consider resources and constraints; finally, Núñez et al. (2009) and Núñez et al. (2012) incorporate adjustments. Taking into account these positions I proposed my own implementation of MD.

I created my materials according to the needs of my students. In this case, I used problem solving to connect them with their context, and they solved mathematical problems; likewise, they solved some problems associated to daily life. These aspects, such as the social class and the environment in which my students live, made the design of the worksheets capture the attention of the students and motivated them. As Richards (2006) expresses, some principles generate and keep students' motivation and connect the task to their contextual reality aiming at attaining a successful learning process. That is why, students' motivation to solve mathematical problems starts in the creation of materials, persists, and increases throughout the process.

Theoretical framework to develop materials. As previously mentioned, the current study was conducted with preschool children, and aimed at improving their knowledge on problem solving in math operations such as addition and subtraction through non-authentic materials. To this regard, Montijano (2014) claims "undeniably the best materials that students may enjoy: personalized, as they cater for different learning styles, and relevant because they respond to the learners' needs as no other material can do" (p. 281). Hence, teacher-designed materials motivate students and benefit them; besides, they offer the possibility to create or adapt materials, boost their creativity and improve their practices in terms of students' interest and needs and context. Nuñez et al., (2004) affirm that, "Teachers as innovative professionals have the potential to explore their creativity by designing materials for their classes" (p. 130). Those

materials offer the opportunity to adjust materials to a pedagogical purpose, and focus on students and teachers' expectations. In this study, the most suitable resource was the use of non-authentic materials to allow the teacher to set clear objectives, adapt the materials, and make problem solving and basic math operations easier, and contextualized for children. Thus, MD was paramount to design the pedagogical intervention and the contextualized worksheets. In this case, SLA principles guided and structured language learning materials under theoretical frameworks.

Informed consent. This stage provided the research participants with information that enabled them to make an informed decision as to whether they wanted to participate in the research study. *Capacity:* ability to acquire, retain and evaluate information. Also, the competence to give consent. *Information:* it refers if data about the study have been communicated to a participant in an effective manner. *Voluntariness:* the participant can exercise the free power of choice to be part of the study without any kind of constrain or coercion. In this stage, I explained parents and the school coordinator about the research study I wanted to develop and delivered the consent form to be read and signed (See Appendix B).

Sensitization. Once I received the parents' permission, I explained participants about the way this project was going to be carried out and the expectations I had at the end of the process. This was the opportunity to know students' will to participate in the research, and the topics they wanted to work about during the implementation of the worksheets.

Implementation of the materials. This is the stage to implement the six contextualized worksheets adapted according to the classroom needs and the research objectives and the pedagogical intervention, aimed at starting from the least complex tasks and gradually move to the most demanding ones. The worksheets were developed in six sessions of 60 minutes each, which implied 10 sessions. The math program regularly allotted 8 hour-sessions per week for math classes. However, I did not intend to overwhelm students with work. I planned to

implement one worksheet per week, but when the completion of class work took longer, I negotiated some time with my colleagues for the completion of the intervention.

Sample of worksheets. The next part is a sample of the lesson implemented acording to the instructional stages presented previously.

Math Worksheet No. 1
Problem Solving, Addition and Subtraction

General objective

- **To solve the problems using addition operation.**

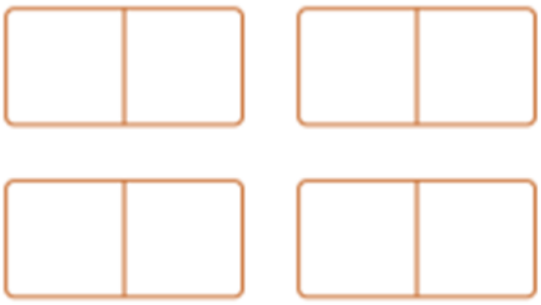
Specific objective

- **To identify the addition and subtraction in a problem.**
- **To recognize the use of realia to solve math operations.**

Name: _____ Date: _____

Addition and subtraction

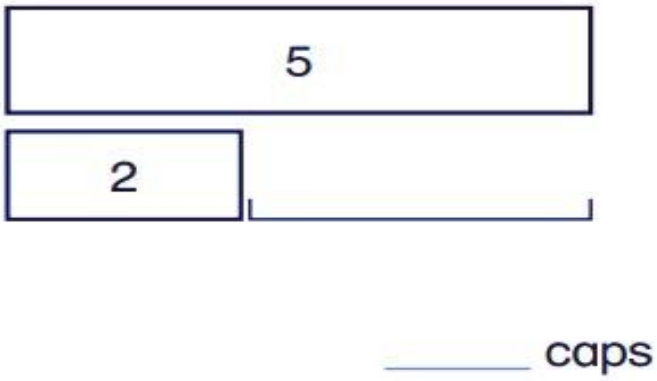
1. **Juan José is drawing dots on the cards to show ways to make 6. Draw dots for Juan José. Write addition sentences for two of the cards:**



_____ + _____ = 6

_____ + _____ = 6

2. Read the problem. Use the bar model to solve it.
Luciana has 5 caps. Lucia has 2 caps. How many additional caps does Luciana have?



3. Draw a picture to solve: Julian has 6 blocks. He gets 5 more blocks. Then he gets 3 more blocks. How many blocks does he have now?

_____blocks

Teacher's feedback

Self -assessment

Hi my dear students,
This section lets me know if you enjoy the exercises. So, put a X in the face happy if you consider that you like and if not put the X in the other face.

About my worksheets	😀	😑
I like the worksheets because they include a variety of activities. Me gustan las guías porque incluyen variedad de actividades		
The worksheets give me the opportunity to discuss and solve math problems, and receive feedback from my teacher. Las guías me dan oportunidad para discutir y resolver problemas matemáticos y recibir realimentación de la profesora.		
The activities use vocabulary that I know, and it makes me feel relaxed. Las actividades utilizan vocabulario que conozco, y me hacen sentir relajado(a).		
I can add and subtract using realia. Puedo sumar y restar utilizando objetos.		
I can understand problems, create a plan to solve it and propose a solution working in groups. Puedo entender problemas, crear un plan para resolver y proponer		
I understand math operations: addition and subtraction. Comprendo las operaciones matemáticas: suma y resta.		

Chapter IV

Data Analysis

Data Analysis Procedure

Data analysis and procedures focused on the main purpose for this study, which is to explore the impact of designing and implementing teacher-created materials based on problem solving, on the comprehension of mathematical operations like addition and substraction among 17 pre-schoolers at a private school. This chapter describes the findings, the methodology and the technique used to collect and analyse data, as well as the procedures followed to interpret the categories, and the results of the pedagogical intervention in this study.

Data collected used in this study were supported by the theories of some researchers to analyse them qualitatively and provide a perspective to facilitate and interpret the process of collectingand anlyzing information. For Creswell (2012), qualitative data analysis deals with "working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others" (p. 145). Thence, the researcher has to decide on the salient aspects of the study, how to organize and group collected data, and the way to present them. In the grounded theory, according to Charmaz (2006), the researcher identifies concepts, phenomena and linkages between elements like keywords or short sentences to establish subcategories that can be grouped into larger and more meaningful categories. In the present study, it was possible to examine and analyze the information and data collected through five patterns as follows: the variety of activities, the discussion of math problem solving, how relaxed students felt with the language used within the activities, their ability to add and substract and the way students understood

problems, create a plan to solve them and propose solutions in groups. From the keywords and the recurrent patterns, subcategories were grouped into some self-contained categories.

Having identified the categories after a meticulous process of data collection, I started by organizing and classifying information emerged from students' artifacts, teacher's field notes, and a focus group interview.

To identify the relevant issues in data collected, I used the color coding technique, which according to Bergaus (2015), is "a way of moving quickly from open coding to the next step of focused coding" (p. 119). Similarly, Taylor and Renner (2003) defined color coding as the process of "giving each theme a different color, keep notes of emerging ideas or patterns and how you are interpreting the data" (p. 6). Finally, Burns (1999) defined coding as "a process of attempting to reduce the large amount of data that may be collected to more manageable categories of concepts, themes or types" (p. 157). Hence, it is a useful tecnique to classify the information and help the researcher find common issues and differences in the data collected to condense it into research categories and subcategories.

On the other hand, I used the triangulation method to give validity and reliability to the results of the study. This method consists of the interpretation of "different perspectives on an issue under study" (Flick, 2009, p. 445). Similarly, Flick (2009) and Denzin (1978) agreed on the identification of three perspectives as follows: investigator triangulation, which includes having different observers for the same phenomenon; theory triangulation, which comprises several theoretical foundations to address the issue; methodological triangulation, which involves mixing methods in the data gathering instruments to guarantee the validity. However, Flick (2009) identified an additional type of triangulation, which is the data triangualton and this entails using several data sources. Out of those perspective, I used the theoretial, methodological and data triangulation. The theoretical one considers the ability to look at findings deeply and

attentively. It means that, it is necessary support everthing with teorical sources. Otherwise, I used those triangulations because it is helpful for me to analyze the research objectives. All the previous information is necessary to understand the research categories and subcategories.

Research Categories

The established categories and subcategories have a straight relation with the instruments and the three constructs helped me identify the impact of designing and implementing teacher-created materials, based on problem solving, on the comprehension of mathematical operations like addition and substraction. They were useful to understand how students developed math operations using problem solving over the process, as shown in the next table.

Table 1: Research Categories and subcategories

Research Question	Research Categories	Research Sub-categories	Salient issues /recurrent patterns
How can the development and implementation of worksheets based on mathematical problem solving impact the development of math operations like addition and subtraction in preeschoolers at a private school?	Contextualized appealing materials supported by teacher's feedback fostered solving math problems	Attractive materiasl and activities supported by teacher's feedback Pair work and discussion to solve math problems in a friendly atmosphere	Pictures and type of activities Feedback understood as teacher's help Discussion opportuties to solve math problems in pairs Feeling at ease - relaxed.
	Progress in solving problems	Solving problems by sharing, making sense and analyzing	Share ideas Comprehend Analyze Solving the problem
	Math operations like addition and subtraction	Understanding math operations and being able to add and substract.	Understanding math operations Being ale to add and substract.

Contextualized appealing materials supported by teacher's feedback fostered solving math problems. The first category evinced in this study is how the design and implementation

of contextualized teacher-created materials contributed to the development of math operations such addition and subtraction of preschool students. In light of Núñez, Pineda and Tellez (2004), “Materials designed by the teachers are more likely to be updated and manageable. That is, they have the possibility of prioritizing the learners and placing them at the center of the language program” (pp. 129-30). Teacher-developed materials also “provide language learners with meaningful highquality input so that it facilitates learner’s language learning targets” (Núñez, Téllez, Castellanos & Ramos, 2009, p. 16). For this reason, the math problems proposed by the teacher included classrooms objects, children’s pets, candies, clothes, blocks and other objets related to preschoolers’ world, whose solution required the use of realia supported by the model bar to make it attractive to children.

By creating my own materials, I motivated my students and guided them in the solution of math probles like addition and subtraction, On this subject, Peacock (as cited in Richards, 2001) stated that the use of contextualized materials in the classroom helps to better understanding and learning the issues being studied. Alons similar lines Núñez, Téllez and Castellanos (2017b) affirm that teacher-generated materials “are more likely to provide learners with rich, contextualized and comprehensible input to facilitate their language learning targets” (p. 24). Thanks to the implmentation of contextualized materials, prescholers had the opportuntity to learn about the resolution of problems using realia while working with their clasamts in a stress-free environment.

Solving math problems is an acivity that raises students’ anxiety; thus, teachers need to permantly expose their students to problematic situations on issues that are familiar to them. As asserted by “students learn by solving problems that are carefully constructed by the teacher according to the course syllabus assigned” (Othman & Ahamad, 2013, p. 2). Moreover, “confronting students with problems from practice … provide a stimulus for learning” (Boud and

Feletti (1997), p. 15) and for building sense of "ownership of the learning … as well as ownership of the problem itself" (Wilson, 1996, p. 140). In other words, the participants were exposed to solving problems posed by the English teacher as a regular practice during the math classes to help them build confidence in making sense of the problems.

Human beings construct knowledge by interacting with others. That is why, materials should offer students the chance to receive feedback (Shall, 1997 and Tomlinson (1998) on the activites they complete. One way of doing so is by asking students to work in pairs and in small groups (3 students) to allow them to exchange their perceptions of their learning experience. In this regard, Núñez et al., (2009), MD implies that "teachers must guide their students to interact in an appropriate manner with their needs and interests to facilitate learning" (p. 184). Throught the pedagogical intervention designed for this study, preschoolers were able to make sense of the problems and handle their solution with confidence. This category entails two subcategories of research: *Attractive materials and activities supported by teacher's feedback and Pair work and discussion to solve math problems in a friendly atmosphere*. The excerpts below present explanation and exemplification.

Attractive materials and activities supported by teacher's feedback. Nowadays, most of the world educational situations have a direct association with the attractive materials for the students. Most people learn through games and through the use of fun materials and visual and tangible materials for the students. In this sense, Sieber (2001) mainatins that "visual literacy is the capacity of interpretation and meaning" (p. 7). In this way, visual and tangible aids help students to interpret the information better. Likewise, Barnard and Zemach (2003) state that "layout should always be carefully considered; an otherwise excellent text and activity can be ruined simply by a badly designed presentation on the page" (p. 317). As discerned by Núñez, Pineda and Téllez (2004) "a crucial aspect in the design of materials concerns the visual layout"

(p. 133); it entails arranging "the information and pictures in a visually attractive layout so that looking at and reading is not tiresome" (p. 133). By carefully organizing and balancing print and illustrations teaching and lerning materials offer more possibilites for intake. On this spirit, Rutter (1988) remarks on "instruments of type, color, paper and format, along with a pinch of intuition and a dash of inspiration" (p. 4). Consequently, kids may learn to solve math problem operations as addition and substraction in a better, easier and more dynamic way as long as they are given attractive visual and tangible materials as a complement to the carefully design worksheets with appealing layout.

Materials tha inlcude meaningful learning activites and allow learners to recongnize in them a sense of usefulness are effective. On this matter, Núñez and Téllez (2009) underscored that "effective materials make learners feel comfortable and confident because both the content and type of activities are perceived by them as significant and practical to their lives". As a result, the teacher designed worksheets aimed at fulfilling the above-mentioned features by promoting significant activities and challenging content in a friendly atmosphere. On this regard, allowing learnes to learn at their own pace, in their own styles, an in an enjoyable, non-threatening atmosphere … will keep their motivation up" (p. 184). Such motivation and appropriate learning setting will enable them to attain their learning targets. Morevoer, by "taking into consideration that our duty as teachers is to care about our students' learning, developing appropriate tailor-made materials that suit all of our learners' profiles is a fundamental must" (Núñez, Téllez and Castellanos (2017b), p. 23). For the abovementioned assertions the pedagogical intervention of this study considered took into account preschoolers' profiles and learning goals in regard to solving math operations.

In connection to teacher's feedback, Hattie and Timperley (2007) define it as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (p. 81). The researchers also assert that

"feedback is one of the most powerful influences on learning and achievement" (p. 81). Based on the previous assertions, the teache-created materials took into account teacher's feedback as an alternative for students' comprehension of math operations and assertive performace. On this matter, Sadler (1989) underscores that feedback gives information related to the learning activity or learning process that closes the gap between what is understood and what is expected to be understood. For Winne and Butler (1994) "feedback is information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies" (p. 5740).

In EFL teaching giving and receiving feedback may be an improvement opportunity. As maintain by Hattie and Timperley (2007), "When feedback is combined with effective instruction in classrooms, it can be very powerful in enhancing learning" (p. 104). Especially for those committed students who are interested in target seeking and task performance, feedback plays a central role in self-correction and improvemetn. In this sense, Podsakoff and Farh (1989) sustain:

> An internal comparison process, which determines how individuals react to feedback. Upon receiving negative feedback, individuals become more dissatisfied with their previous performance level, set higher performance goals for their future performance, and perform at a higher level than those who receive positive feedback or no feedback at all. (p. 62)

Then, the pedagogical intervention of this study deems teacher feedback as essential for student's self-realization of their mistakes and self-investment in target and learing achievement.

The following excerpts taken from the students' artifacts show how the worksheets, the model bar including blocks, teddy bears, jelly beans, and marshmallows helped students solve math operations.

Math Worksheet No.1
Problem Solving, Addition and Subtraction

General objective

- **To solve the problems using the addition operation.**

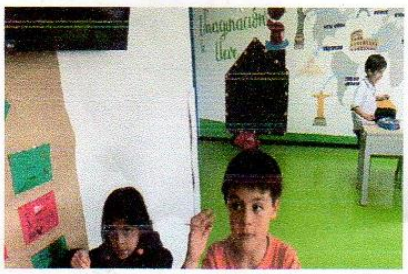
Specific objective

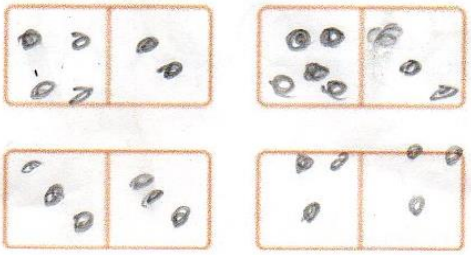
- **To identify the addition and subtraction in a problem.**
- **To recognize the use of realia to solve math operations.**

Name: Juan esteban Arroyo **Date:** 20/1/22

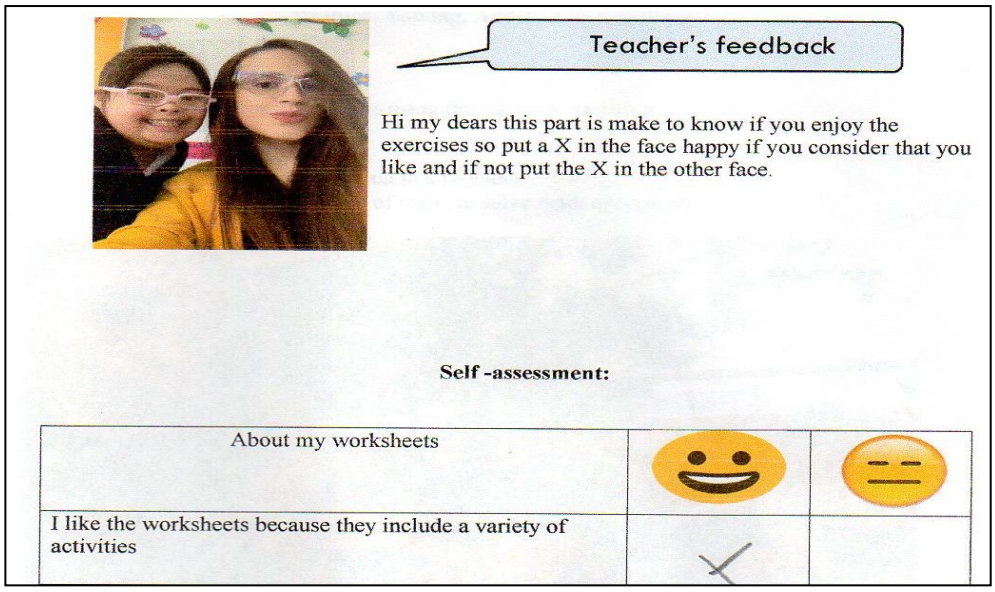
Addition and subtraction

1. **Juan José is drawing dots on the cards to show ways to make 6. Draw dots for J José. Write addition sentences for two of the cards:**





(Students' artifacts, Worksheet N°1)



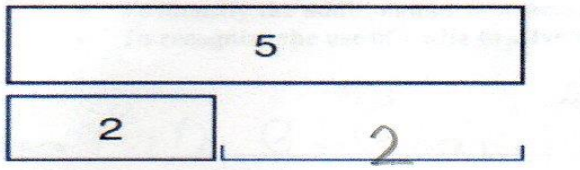
(Students' self-assessment, Worksheet N°1)

Pair work and discussion to solve math problems in a friendly atmosphere. This subcategory explores how student pair works and disccussions emerge during the process of solving problem and why it is necessary to have a friendly atmosphere to develop the problems. In this moment, what really matters is that the students stay in a pleasant and quiet environment without pressure, so that they can work in groups and share their ideas, in addition to having fun when using tangible materials provided by the teacher. According to Stoller (1997), when students work in groups, they share resources and efforts to achieve common goals; it also creates a class atmosphere in which learners feel motivated to learn with and from the others (Hudelson, 2001). Moreover, teachers should "develop a comfortable warm-hearted learning atmosphere in the EFL classroom, and to be more understanding to the point of becoming quite fond of their students" (Núñez et al., 2009, p. 18). Teachers should "create a language learning atmosphere that keeps students' attention and imagination going" (Núñez et al., 2009, p. 18). "Students learn better when they are motivated and comfortably engaged in a non-threatening or non-discouraging language learning setting. Besides, the learning process must be an enjoyable, long-

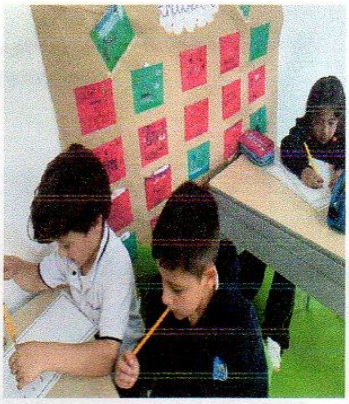
lasting, and interactive process" (Núñez et al., 2009, pp. 11-18). In sum, group work and discussions may create a friendly atmosphere as students feel motivated when working with their peers as they can learn from one another, and they can share their ideas and resources to join efforts to solve math problems. Besides, teachers should be understanding, warm-hearted and create an enjoyable and interactive setting, as the one previously described.

Furthermore, children's emotions were lost when they had the need to play realia. Agreeing with Richards (2005), there are key factors such as the school culture, classroom conditions, class size, and teaching resources availability of suitable materials. This means, that the teacher must adapt and design materials under the students' conditions. Accordingly, there were problems where no changes occurred; however, I adapted them partially, in favor of students' needs to foster motivation. Conversely, they wanted to play, and as mentioned by Jonassen (2013), a problem solving is not successful if the students lack motivation.

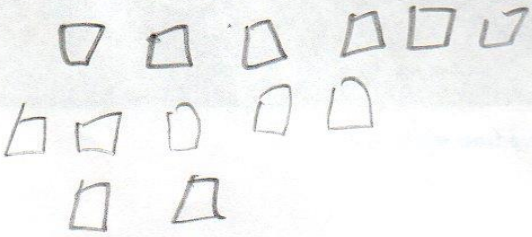
2. Read the problem. Use the bar model to solve it.
Luciana has 5 caps. Lucia has 2 caps. How many additional caps does Luciana have?



2 caps



3. Draw a picture to solve: Julian has 6 blocks. He gets 5 more blocks. Then he gets 3 more blocks. How many blocks does he have now?



14 blocks

6 + 5 + 3 = 14

(Students' artifacts, Worksheet N°2)

The worksheets give me the opportunity to discuss and solve math problems, and receive feedback from my teacher		

(Students' self-assessment, Worksheet N°1)

The evidence found in the teacher's field notes unveiled similar characteristics as the ones mentioned in the first category. Students discuss the possible answers to the situations given by working in pairs. They use realia, a model bar, they are able to identify the correct math operation, and in the end, they know what to do. The excerpts shown below give account of these features.

> During the whole discussion, students give answer to questions proposed by the teacher.
> In the first activity, students work in pairs and try to solve the problems using the realia Then, through the Model Bar, they identify if the operation that they have to use was an addition or a subtraction.
> ***(Field notes N°1)***

> Students MC: Like this, Miss? [*sic*] (trans)
> Teacher: Kids read the problem with your group and then at the final of the activity I will give you the answer.
> Students CS: We just need to solve the problems with the candy. [*sic*] (trans)
> ***(Field notes N°3)***

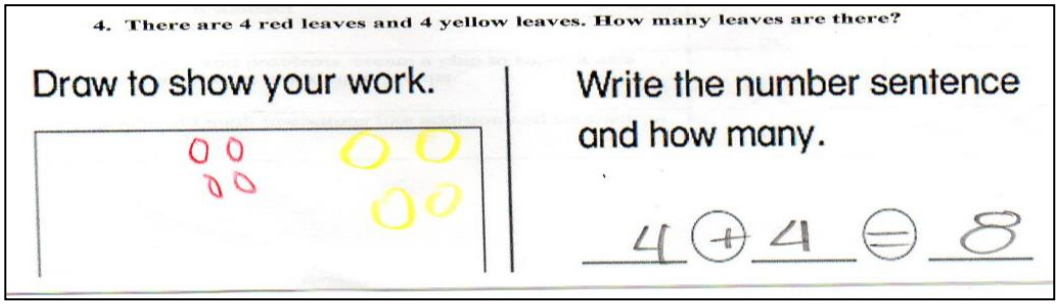
A feature that particularly stands out from the focus group interview is students' perceptions towards the activities and how they felt when developing them. Although they are very young learners and their answers were short, they had positive responses to math operations.

1. How do you feel when doing the activities?
   - Happy
   - Quiet
   - Happy
   - Quiet
   - Excited

   [*sic*] (trans)
   (Focus group interview)

Progress in solving problems. The progress in solving problem as the way to develop students' knowledge in the solution of math operations like addition and subtractions through the analysis of problem situations, it leads us to thinking about. Piedra (2015) asserts that developing creative thinking focused on strategies enables students to develop critical thinking skills such as interpretation, analysis, evaluation, inference, explanation and self-regulation. All of these moments are important in both math and English learning processes. Nevertheless, Núñez and

Téllez (2009) indicate, MD implies that "teachers need to lead their students to have materials interact appropriately with their needs and interest in order to facilitate learning" (p. 184). In the same line of thought, Allwright (1981) envisons EFL lessons as an interaction between the teacher, the learners, and the materials, whose purpose is to render opportunities to learn. Consequently, students started to inspire and motivate; however, after working on four worksheets centered on the same structures, it affected students' interaction with the material and motivation. Therefore, this category deals with the next sub categorie: *Solving problems by sharing, making sense and analyzing*, justified and evinced ahead.



(Students' artifact, Worksheet N°3)

10

Math Worksheet No. 4
Problem Solving, Addition and Subtraction

General objective

- To solve the problems using the addition and subtraction operations.

Specific objective

- To identify the addition and subtraction in a problem.
- To recognize the use of realia to solve math operations.

Name: Martin Sanchez **Date:** 10 June

Problem solving

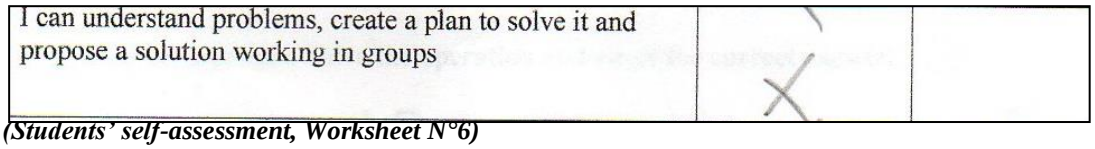
Solve the problems using the materials give by the teacher and write the correct answer

1. **There are** 5 **ladybugs. Then** 3 **more ladybugs come. How many ladybugs are there now?**

8 **ladybugs**

5
\+ 3
8

(Students' artifact, Worksheet N°4)



(Students' self-assessment, Worksheet N°6)

Solving problems by sharing, making sense and analyzing. Solving problems by sharing, making sense and analyzing are difficult meanings to understand for students. In this part, the student skips the problem conceptualization process. This happens because, according to Chi, Feltovich, & Glaser, (as cited in Jonassen, 2013):

> Students tent to use an intuitive problem-solving approach, rather than a scientific problem-solving process. Several studies have suggested that a distinct difference between expert and novice problem solvers is that experts tent to qualitatively analyze the problem (that is contextualized the problem and construct a problem space) when first faced with a problem, while novices are apt to seek out solutions immediately in the first attempt. (p. 180)

Thus, students from preschool skipped the procedure because they deduced the answer and wanted to finish as soon as possible because the procedure became a boring routine.

The issues that feature this category are related to the way students were able to read the math problems, show, compare and support their answers by using realia. They also could identify new words and despite the whole process seemed difficult, it was easy for them.

> Teacher affirms they should say what the missing related fact is, and give a reason for their answer.
>
> Finally, they show their answers to the rest of the groups. Students compare the answers in which each student is expected to say their reasons.
> ***(Field notes N°2)***
>
> Teacher: ok, kids read the problem and please underline the new words.
> Student LR: Miss, I don't want to do that anymore. [*sic*] (trans)
> Teacher: This problem is very easy, we already finished.

Students MD: This is very easy. [*sic*] (trans)
Students SV: Do I have to finish all of it? [*sic*] (trans)
Teacher: yes, you do SV but you have to read, use the realia and then solve the problem.

Teacher: That's it. Do you have another option to solve the problems? What do you need to do?
Students PM: Solve the math operations [*sic*] (trans)
Teacher: Math operations. That's good.
(Field notes N°3)

The next excerpts taken from the focus group interview, portray how solving math problems is easy when working in groups because students can ask their peers. Despite being taught in English, language was not a boundary and most of children understood when their teacher read the situations and they even expressed those problems were beautiful.

2. Do you think the worksheets give you the opportunity of speaking and solving math problems?

   - Yes, because we can always ask the others.
   - (Math) problems are easy
   - It's easier when we all work together.
   - Yes, because sometimes the problems are difficult and I ask if we don't understand.
   - They are very beautiful and easy to develop.
     [*sic*] (trans)

   (*Focus group interview)*

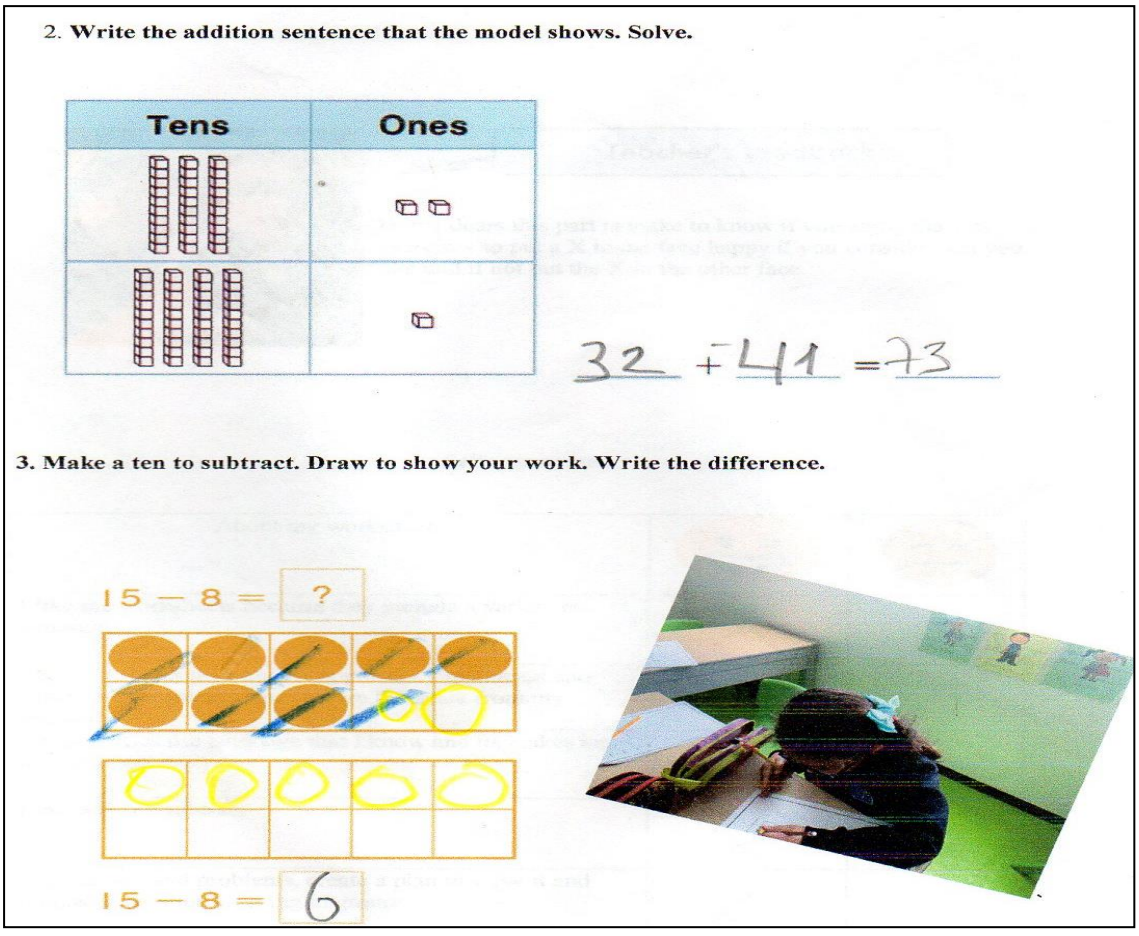
4. Do the activities use the language you know?
   - Yes, sometimes I don't understand well.
   - Just when the teacher reads
   - It is easy… we just need to pay attention
   - Yes.
   - I know everything she says.
     [*sic*] (trans)
     (Focus group interview)

7. Is it easy for you to understand the problems, create a plan to solve it and then find a solution?
   - It's not that easy, but I understand.
   - They are very easy.
   - I understand everything.
   - It's easy to solve them.
   - It's easier when we work in group.
     [*sic*] (trans)
     (Focus group interview)

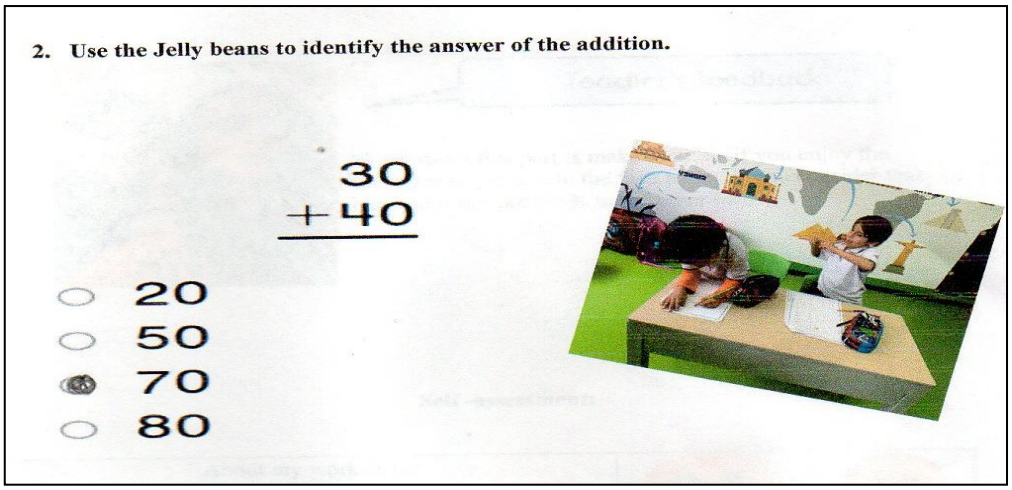
Math operations like addition and subtraction. The teaching of math operations is a fundamental part of the principles of mathematics. At the age of 5 to 6 it is important for students to learn how to add and subtract, but this has become a tedious and often frustrating task for

students. That is why, in the present study, the problem solving is unified with the teaching of this basic operations, such as addition and subtraction.

More precisely, in Baroody's (2016) words, "Children informally recognize that addition of items makes an initial collection larger and taking away makes an initial collection smaller, even before they develop counting-based strategies" (p. 164). In this sense, children at early ages recognize what adding and subtracting mean. Even without knowing the subject itself, they also do mind operations by associations of magnitude of quantity; then, the use of realia helped the students associate the quantities with the numbers and so it would be easier for them to perform mathematical operations on paper.



(Students' artifact, Worksheet N° 2)



(Students' artifact, Worksheet N°3)

(Students' self-assessment, Worksheet N°2)

This leads us to say that "Fluency with developmental prerequisites is necessary to achieve fluency with a reasoning strategy, including the subtraction-as-addition strategy" (Baroody, 2016, p. 168). Therefore, this category deals with the next subcategory: *Understanding math operations and being able to add and substract*, justified and evinced ahead.

Understanding math operations and being able to add and substract. Understanding math operations and being able to add and substract, making sense math operations can be understood in a flexible way by handling the previous concepts that students have of quantity so that they also associate quantities with mathematical operations. This leads to assert that, "The operations of addition and subtraction can be seen as dynamic processes between a part, another part, and a whole. Once this idea is formed, the relationship between the three quantities can be

treated flexibly". (Fritz et al., 2014, p. 144). The use of real aid helps these previous concepts of quantity to be more notorious and thus, they can be exemplified as addition or subtraction.

In this sense, the model bar used helps us to regulate and to flixize the content of the realia so that the students have a greater approach to the concept of math operations and thus, they are facilitated to solve the operative problem with the simple fact of felixibilizar the prior knowledge; therefore, "The idea is to facilitate an understanding of the reasoning behind the addition operation as a (conceptual) task that flows from conceptual understanding" (Fritz et al., 2014, p. 144). Consequently, the teacher is a facilitator for students to understand basic concepts, instructions and procedures to get to the solution of problems.

> Then, through the Model Bar, they identify if the operation that they have to use was an addition or a susbtraction, those concepts are clear to the students and the context of the classroom environment.
>
> **Student SJ**: Miss, can we put a sad face? [*sic*] (trans)
> Teacher: Just in case you feel that you can't do the exercise and the candy doesn't help you solve the problems.
> **Student SJ**: Ah, no teacher I put a smiley on everything because it was easy. [*sic*] (trans)
> ***(Field notes N° 1)***
>
> They get interested in the solution and solve the problem easily and relaxed**.**
> Students SV: the first answer is 8
> Student LR: the second one is 32 plus 41[*sic*] (trans)
> Student CS: Not like this, you have to say "the second one" [*sic*] (trans)
> Student Sj: the second answer is 32 plus 41
> Student CS: the third answer is ….
> Teacher: What is that? How many balls does it have?
> Students: one, two, three, four, five, six, seven with the jelly beans
> Teacher: so, you have the answer
> Students CS: six
> Students: five
> Teacher: no, it's eight
> Students: ahhhh.
> ***(Field notes N° 2)***
>
> In the course of the problem part, students did not spend too long reading and understanding the situation. They also identified that they had to classify the operations easily. It was an easy activity because during the last session they were using the candy to solve the problems.
> ***(Field notes N°3)***

Data gathered through the focus group interview display how students were able to differentiate addition from substraction as they expressed it was easy and nice to them. In this

identification, they found out the proper signs for each operation (+ or -), but more significantly, they realized they would eat jelly beans if they had to substract; otherwise, they would not know which was quite interesting for this study.

3. Did you learn how to add and susbtract?
- Oh yeah
- Yes
- Yes, it's easy
- Yes, it's nice
- Yes

[*sic*] (trans)

8. Is it easy for you to differentiate math operations like addition and substraction?

– It's easy because the cross-means addition.
– It's easy because we sometimes substract and other times we add.
– It's easy because I eat the jelly beans when I susbtract and when I add I don't (eat jelly beans).
– I sometimes get confused.
– It's easy… just because

[*sic*] (trans)
(Focus group interview)

Having described this subcategory, the next excerpts intend to explain evidences selected from teacher's field notes. In general, students used the bar model as a resource to identify whether the correct math operation to solve the problem was addition or substraction, and it was evinced that it was easy for them. Children did the whole process fast, as they understood the situation by using realia and they were involved in a relaxed atmosphere as part of their success.

The comprehension of mathematical operations is key to enrich the mathematical knowledge at an early age, and make students feel comfortable and relaxed to learn.

Chapter V

Conclusions and Pedagogical Implications

After discussing data analysis of the current study, this chapter presents the conclusions, pedagogical implications, limittons and questions for further research.

Conclusions

This section illustrates the most significant findings and the most relevant conclusions of this research study emphasised on the development and implementation of contextualized teacher-created worksheets based on math problems solving. In addition, the way that it influenced the comprehension of mathematical operations of addition and substraction among pre-schoolers in a private school.

Moreover, this chapter highlights the positive impact of developing and implementing innovative contextualized teacher-created materials based on problem solving, for the comprehension of basic mathematical operations of addition and subtraction. It also highlights the impact of the problem solving in group work interaction, which grealty favored the comprehension of these math operations, and describes the way in which students solve addition and subtraction problmes using realia.

After accomplishing this study, I can say that as suggested by Núñez and Téllez (2009), MD provided opportunities for students to associate their interests with mathematical contexts. Furthermore, MD helped students to improve their skills of math operations. They had a proper uptake and feeling with images and worksheet presentation. Indeed, worksheets structures facilitated opportunities for problem solving in parallel during the implementation. Even though, after four sessions students declared being tired of working just in the books and making math

operations with any help. This situation made me think of other possibilities to adapt and create materials in response to students' needs and interests.

Similarly, in problem-solving activities the preeschoolers want to develop the problems involves the addition and the subtractions in a different context and using tangible materials, as mentioned by Reys (2006) "Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves" (p. 6). Despite children's emotional struggle with problem solving procedures, they wanted to play and use realia. Furthermore, they started to skip the problem-solving procedures, and assumed a good solution procedure in the beginning of the implementation. Then, they omitted understanding and planning steps, and the most important stages to contextualize the problem. Nevertheless, children solved, checked and exposed their ideas and solution to their classmates.

In regard to math operations, students reached new ways to solve mathematical problems, especially addition and subtraction. Then, they practiced that in context. The students used realia to solve the problems easily (Baroody, 2016). Moreover, they showed difficulty to use the model bar to solve problems and use the incorrect symbols of the addition and subtraction.

Pedagogical Implications

The pedagogical implication of this research study associates to three aspects: first, materials development, next, mathematical problem solving; finally, math operations of addition and subtraction. In terms of materials development, it is important for teachers who want to develop materials to keep in mind the real needs and the interests of their students (Núñez & Téllez, 2008, 2009, 2015; 2018). In my case, I considered relevant to create different worksheets and the use of realia to all the process. It means that I did not follow the same structures in all of them due to the evidences of my students' tiredness toward the same type of activities. In

addition, I created the materials taking account the SLA Tomlinson's principles, which helped me and guided my implementation and development.

In what concerns to problem solving, I have learned that when students solve a problem, they develop multiple learning and thinking skills. In that sense, it is important to provide students with significant activities that promote real situations in which they are aware of their learning progress (Byrne, 1991and Nixon, 2012). Problem solving enhances students' way of solution of math opertions. I believe that teachers who want to teach math operations through any content can use problem-solving approach, not only to teach math, since it involves science, social studies or a series of subject matters, as problem solving contributes to innovate in students' daily contexts. Even though, as I mentioned before, it is important to develop different strategies to avoid children's boring routine, which might lower the level of motivation.

In relation to math operations, I concluded that preeschoolers learn more easily when they understand mathematical operations through the use of real concrete objects and the problem-solving approach, as well as using the model bar. To solve mathematical operations, it is necessary to have previous concepts of what is the addition and subtraction. As a teacher-researcher, I consider mandatory to pay attention to every comment that the presscholers made, as the foundation to do feedback to the better understanding of the process. The students have many questions to ask, and sometimes, the teacher ignores them, leaving a black space in their minds. Finally, this study made me more auto-dicdactic and creative at the time to create a good class for the preeschoolers. To conclude, I have to say that now I am aware of the importance of teaching in a good way, be clear and listen to all questions of my preeschoolers and pay special attention to their feelings and emotions.

Limitations

The main limitations of this study were the lack of spaces to implement the materials, since I only had two hours a week and had to work on the school curriculum plan, which already has an established schedule regarding activities and topics. That is why, I had to ask for the help of my coworkers who kindly allowed me to take their class hours to carry out this study. Another very big limitation was my critical health conditions, which kept me away from the classroom for almost a year, thus, I often had to appeal the school staff's support to let me address my research.

Questions for further research

During the development and implementation of this research study, I realized that my preschoolers have a great fascination for technology, especially computer games to learn in a significant way with the use of technological resources. Moreover, I would like to continue working with preescolers to encourage them to integrate the problems solving in math operations of addition and subtraction, but with use of technological aids. In that sense, my further research inquiry would be, "What is revealed about the development and implementation of the technological aids to solve math operations like addition and subtraction trougth problem solving in preschoolers?"

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Appendices

Appendix A: Consent Form

Bogotá, febrero de 2019

Padres de familia y estudiantes grado quinto
Jordan de Sajonia School

Apreciados padres de familia y estudiantes:

Cordialmente me dirijo a ustedes con el fin de solicitar su colaboración en la realización del proyecto de investigación de una Maestría en Educación con Énfasis en Didáctica del Inglés que estoy adelantando en la Universidad Externado de Colombia. El proyecto se denomina “Teacher Created Materials Focused on Math-Problem Solving” y tiene como propósito hacer un análisis del impacto que tiene un recurso didáctico que diseñé (worksheets) en el desarrollo de habilidades de resolución de problemas matemáticos implementados en las operaciones matemáticas como lo son la suma y la resta.

Los temas a tener en cuenta para desarrollar el material serán seleccionados teniendo en cuenta los intereses particulares de los estudiantes y estarán alineados con el programa de matematicas que actualmente se imparte en el JDS.

La participación de sus hijos(as) consiste en la realización de 6 talleres que hacen parte de un cuadernillo didáctico, el cual ustedes podrán conocer si así lo desean. Los instrumentos aplicados para recolección de datos, así como el material desarrollado durante la implementación de este proyecto serán utilizados con propósitos académicos y con fines investigativos únicamente.

Cabe aclarar que la participación de su hijo (a) en este proyecto es de carácter voluntario y no ocasionará ningún inconveniente si desea no hacer parte de la investigación. Asi mismo, se garantiza la confidencialidad de la información obtenida producto de esta investigación y la protección de sus nombres en el análisis de resultados.

De antemano agradezco su valiosa colaboración y participación.

Cordialmente,
Carla Rodriguez Ruiz
Docente de Matematicas

Nosotros _____ y _____
padres de _____ del curso _____ autorizamos la participación de nuestro hijo(a) en el desarrollo de este proyecto de investigación.
Firma del padre: _____ Firma de la madre: _____
Yo _____ estoy dispuesto a participar en el desarrollo de este proyecto de investigación.
Firma del estudiante: _____

Appendix B: Field Notes Form

Universidad Externado de Colombia

Class development	**Description**	**Analysis**
Date: _____ Whole Class Discussion Personal Task Performance Team Work: Pair/Small group Work		

Appendix C : Survey

Survey for pre –school

Me gustaria conocer tu opinion sobre la clase de matemáticas. Marca con una X la carita con la que te identificas.

Nombre: _____ Fecha: _____

Pregunta			
¿Te gusta la clase de matemáticas?			
¿Te gusta que la clase sea en inglés?			
¿Le entiendes a la profesora cuando te explica en inglés?			
¿Entiendes las operaciones como la suma y la resta en inglés ?			
¿Te gusta resolver problemas matemáticos en inglés?			
¿Crees que es importante aprender a sumar en inglés?			
¿Consideras importante los temas de geometría para la relación con tu entorno?			
¿Te gustan las actividades que realiza la profesora para resolver los problemas?			
¿Te gustan utilizar juguetes, gomas o dulces para			

apreder a sumar?			
¿Te gusta la clase que la profesora prepara utlizando canciones y juegos?			